



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

kept dry and at the same temperature as the atmosphere outside. The roof of the observatory is in two parts, one of which rolls east and the other west, leaving a clear opening of six feet. While observing, all other openings are closed, and if the wind is blowing too hard, the roof-opening is also contracted. The meridian-mark is viewed through a north door. The pier on which the mark is mounted is sheathed with tinning and protected by a wide lattice structure, so as to guard against warpings from the direct rays of the sun. A pendulum-clock, beating seconds, a self-registering barometer, and several other minor instruments have been provided for each station.

UKIAH, CALIFORNIA, 1899, Nov. 20.

THE *PERSEID* RADIANT.

BY W. H. S. MONCK.

Mr. DENNING's recent paper in the *Memoirs of the Royal Astronomical Society* has, I think, placed beyond doubt that in the vast majority of cases meteors come from the same radiant point at different seasons of the year. The coincidences are far too numerous and too close to be the result of chance. There must, generally speaking, be some physical connection between the various meteors which Mr. DENNING classes together, and the duty of the physicist is not to ignore this fact, but to explain it. Theoretically,—I mean in accordance with the current theory,—all showers which last for more than one night ought to shift. But they do not. Mr. DENNING mentions but two shifting radiants—the *Lyrids* and the *Perseids*—and he is doubtful as to whether the apparent shifting of the former is real. He further points out that there is a permanent, or stationary, radiant almost coincident with both. This is a significant fact, and throws a difficulty in the way of proving the actual shifting. At all events, Mr. DENNING's catalogue justifies the assertion that stationary radiation is the rule, and shifting radiation the exception—if indeed there be any exception. This is the exact opposite of what the current theory would lead us to expect; and consequently the current theory must, I apprehend, be wrong.

My main object is, however, to deal with the *Perseid* radiant, which is the stronghold of all who believe in shifting radiants,

some of whom seem to me to forget that one swallow does not make a summer. Now, I wish to call attention in the first place to a peculiarity in this part of the sky. There is scarcely a spot in the region of *Perseus* and the adjoining parts of *Cassiopeia*, *Camelopardus*, and *Andromeda* from which meteors do not come to us at various seasons of the year. We seem here to have not a number of radiant points, but a radiant area. Most of the radiants in this part of Mr. DENNING's catalogue are, moreover, ill-defined. Some of the positions are at a considerable distance from the assigned center; and there is often no distinct line of demarcation between the meteors assigned to two adjacent centers. It is easy to prove this without referring to the radiants which Mr. DENNING refers to the great shifting *Perseid* shower. The R. A. of the forty-four radiants which he describes as "*a Cassiopeids*," with a center at $7^{\circ}.1 + 51^{\circ}.9$, varies from 0° to 16° , and the Declination from $+49^{\circ}$ to $+57^{\circ}$. The extremes for the " *δ Cassiopeids*," with a center at $19^{\circ}.2 + 57^{\circ}.7$, are R. A. 10° to 26° , and Decl. 51° to 65° . I need not specify the limits of other radiants in this region. They are all of the same description, and their classification is evidently to a large extent arbitrary. In the case of the two *Cassiopeid* showers, a radiant at $8^{\circ} + 55^{\circ}$ is placed under one head, and a radiant at $10^{\circ} + 56^{\circ}$ under the other. Both were observed in the first half of August. Radiants at $24^{\circ} + 50^{\circ}$ and $22^{\circ} + 49^{\circ}$ are classed as belonging to a center near γ *Andromeda*, whereas radiants at $20^{\circ} + 50^{\circ}$, $20^{\circ} + 52^{\circ}$, and $24^{\circ} + 52^{\circ}$ are classed as *δ Cassiopeids*. Radiants at $26^{\circ} + 48^{\circ}$ and $25^{\circ} + 46^{\circ}$ are referred to the *Andromeda* center, while one at $28^{\circ} + 45^{\circ}$ is described as a " *θ Perseid*." Mr. DENNING is himself doubtful whether the "*a Perseids*" constitute a distinct shower. The *η Perseids* include a position at $50^{\circ} + 54^{\circ}$, and the "*a Perseids*" one at $54^{\circ} + 54^{\circ}$. These " *η Perseids*," however, are even more closely connected with the " *χ Perseids*," the former containing positions at $39^{\circ} + 57^{\circ}$, and $40^{\circ} + 59^{\circ}$, and the latter at $36^{\circ} + 57^{\circ}$, $38^{\circ} + 59^{\circ}$, and $38^{\circ} + 60^{\circ}$. All these centers—two in *Cassiopeia*, one in *Andromeda*, and three or four in *Perseus*—are active not merely during July and August, but during a great part of the year. We have in fact a permanent, or stationary, radiant area in which some points seem to be peculiarly active, but no satisfactory reduction to a definite number of stationary radiants can be made.

It is, then, across this stationary radiant area that Mr. DENNING

thinks he can trace the path of a shifting shower lasting from July 11th to August 20th. It is not, I think, contended that the meteors belonging to this shifting shower possess any physical peculiarity by which they can be recognized. All meteors coming from this region of the sky are of the same swift, streaky kind. No point on the supposed track of the shifting shower becomes active for the first time when that shower reaches it, or ceases to be active as soon as the shower has passed over it; nor is the surrounding portion of the sky quiescent when the moving point is active. All therefore that could be proved is that a line can be drawn across this radiant area running nearly due east, the various points on which successively attain their *maximum* activity, the daily change in the position of the maximum being about 1° . The strength of the shifting shower would be measured at each point on this line by the excess of the activity on the night in question over the normal activity of the same point at this season of the year. Has Mr. DENNING proved the existence of these successive *maxima* all along his line?

It is most convenient to deal with the subject in sections. I begin with the period extending from July 11th to July 26th, inclusive. During these sixteen days Mr. DENNING has only been able to find seven radiants which he can refer to this shifting shower. Two of these seven positions are deduced from observations extending over several nights—one from the 8th to the 13th, and the other from the 22d to the 27th of July. This would be a very unsatisfactory course if the radiant were really shifting at the rate of 1° in R. A. for each night. He finds no position on the 14th, 15th, 16th, 17th, 20th, or 21st of July which falls in with the theory of shifting. The initial position at $11^{\circ}+48^{\circ}$ on July 11th (rather July 8–13th) falls within the region of the α *Cassiopeids*, which is then active. It is deduced from ten meteors. But I find an α *Cassiopeid* position at $11^{\circ}+50^{\circ}$ deduced from twenty-six meteors from July 21st to August 1st, and another at the same point from twenty-nine meteors on August 9–13th; consequently it would appear that this radiant, so far from attaining its maximum activity during the period July 8–13th, is more active a full month later. Why not, then, class this radiant at $11^{\circ}+48^{\circ}$ simply as an α *Cassiopeid*? It would no doubt be so classed if it occurred at any other date. The other radiant, which Mr. DENNING deduces from several days' observations, is at $23^{\circ}+49^{\circ}$ for the period July 22–27th.

No one can doubt, I think, that this is a different determination of the same radiant as HEIS's $24^{\circ}+50^{\circ}$ for July 22-25th, which Mr. DENNING classes as a " γ *Andromedid*." It might also, however, have been referred to the " δ *Cassiopeids*," which yield positions at $24^{\circ}+52^{\circ}$ and $25^{\circ}+51^{\circ}$, running insensibly into the *Andromeda* radiant, as usually happens in this part of the sky. The five remaining determinations rest on a single night's observations. They give $17^{\circ}+50^{\circ}$ for July 18th, $19^{\circ}+51^{\circ}$ for July 19th, $25^{\circ}+52^{\circ}$ for July 22d, and also for July 23d, and $22^{\circ}+52^{\circ}$ for July 25th (where it will be seen that the change of 3° from its immediate predecessors is in the opposite direction from what the shifting theory requires). All five positions lie within the limits of the δ *Cassiopeids*, which are active both before and after; and as none of them are deduced from more than five meteors, the normal activity of the δ *Cassiopeids* at this time of the year seems sufficient to account for them. Up to the 27th of July there seems to me to be no proof of the existence of any shifting radiant in *Cassiopeia* or *Perseus*.

From this date to the middle of August the observations become more frequent, but they are still all referable to centers of radiation which are active both before and after. A remarkable instance of this kind meets us at the outset. Mr. DENNING gives three determinations of the shifting radiant at $32^{\circ}+53^{\circ}$ for July 28th, July 30th, and July 31st, respectively. Taking a mean between these and certain other radiants observed on the same days, a shifting appears to result; but it is not the less true that meteors reach us from what appears to be a rather sharply defined radiant at $32^{\circ}+53^{\circ}$ for four days in succession. Further, on turning to the " θ *Perseids*," I find the position $32^{\circ}+53^{\circ}$ set down for the period July 25th-August 1st. Surely this is merely a different observation of the same shower that has been already referred to the shifting radiant. The other positions of the shifting radiant at this period agree closely with those given under the head of " θ *Perseids*," " χ *Perseids*," and " η *Perseids*." I am not blaming Mr. DENNING for thus mixing up the meteors belonging to the supposed shifting radiant with others belonging to stationary radiants situated in the same part of the sky. This is in fact inevitable. Let us suppose that the normal activity of a given radiant is represented by three meteors per night, while the effect of the shifting radiant passing over it is to add three meteors for the night of passage. The radiant for that night will

be determined from six meteors, three of which belong to the fixed and three to the movable series. But then the real question in each case will be, Is the normal activity of the radiant clearly exceeded at the date assigned to the passing of the shifting radiant over it? For it is only by means of the addition thus made to the normal activity that the existence of the shifting shower can be proved at all.

That the normal activity of the main radiant situated at about $44^{\circ}+56^{\circ}$ is largely exceeded on the 10th and 11th of August must be admitted. But I think also that the activity of the various positions assigned by Mr. DENNING to the shifting radiant between the 1st and the 10th of August is in excess of the normal amount at the dates assigned. The statistics on this point are not very definite, nor ought the mean of a number of radiants on a given night to be used unless *all* the radiants in that part of the sky are taken into account. It would be easy to prove the shifting by selecting the radiants which agreed with that theory, and rejecting those that did not; but the only legitimate course is to consider all the observed radiants, whether favorable or adverse to the theory. If ten radiants are observed on the same night in the same region of the sky, it is not legitimate to take an average of seven and to leave out the other three. This at least ought not to be done until the existence and nature of the shifting radiant has been placed beyond doubt by an impartial examination of all the available observations in that region; for of course, after proving the existence of a shifting shower, we might adopt a different course from that which is requisite in proving it.

But after the 12th of August Mr. DENNING's catalogue seems to me to be open to objections of the same kind as those which apply to the earlier part of it. The radiants described as belonging to the shifting showers may be equally classed as *Cameloparids*, and there is no evidence that this shower attains its maximum activity at the date assigned to the shifting radiant by Mr. DENNING. Thus a position at $55^{\circ}+57^{\circ}$ on the 15th of August is described as belonging to the shifting *Perseid* radiant, while one from precisely the same point on August 9th and another on August 20-25th are described as belonging to the stationary *Cameloparid* radiant. The former radiant is derived from five meteors, and that on the 9th of August from six, so that there is no reason for regarding August 15th as the date of maxi-

mum activity. A position at $58\frac{1}{2}^{\circ}+59\frac{1}{2}^{\circ}$ on August 15th is referred to the shifting radiant, but the *Camelopardids* give positions at $58^{\circ}+58^{\circ}$ for August 8-13th, at $59^{\circ}+60^{\circ}$ for August 14-19th, and $60^{\circ}+59^{\circ}$ for August 16th. Some at least of these supposed shifting positions appear to be different positions of the same *Camelopardid* radiant, which continues unaltered for at least two months. $50^{\circ}+62^{\circ}$ is given as a *Camelopardid* position for August 3-17th; but within the same limits of date I find among the determinations of the shifting radiant $49^{\circ}+62^{\circ}$ on August 13th, and $54^{\circ}+62^{\circ}$ and $58^{\circ}+62^{\circ}$, both on August 18th, while $55^{\circ}+62^{\circ}$ occurs on August 21st. In none of these instances does there appear to have been any abnormal activity at the time that the shifting radiant is supposed to have reached the particular points referred to, and the evidence of any shifting radiant after August 12th seems to me weak. Evidence worthy of the name is, I think, limited to about ten days out of the forty; and even as regards these ten days, it is not of a very overwhelming character.

I have already noted that it is impossible for an impartial student of Mr. DENNING's catalogue to come to any other conclusion than that the meteors which reach us from the same radiant at different seasons of the year are physically connected. Now there is a permanent, or stationary, radiant just at the point from which the great shower on the 10th and 11th of August emanates. This stationary radiant is active both before and after the great shower. Mr. DENNING (who speaks of these meteors as "*η Perseids*") gives one determination at $45^{\circ}+57^{\circ}$ for July 15th-August 2d, another at the same point for July 25-31st, and a third at $43^{\circ}+58^{\circ}$ for July 26-31st. In August I find $43^{\circ}+57^{\circ}$ on the 3d and 4th, $42^{\circ}+57^{\circ}$ on the 5th, $45^{\circ}+57^{\circ}$ on the 6th, $43^{\circ}+56^{\circ}$ on the 13th, $40^{\circ}+59^{\circ}$ on the 21st, and $45^{\circ}+57^{\circ}$ for the period August 24th-September 14th. Some of these are referred to the stationary radiant and others to the shifting one; but the net result appears to be that there is a shower from the same radiant that is active on August 10th and 11th for a month before and after that date. Are we, then, to suppose that this grand shower is physically connected with two meteor-swarms totally unlike in their characteristics, one being fixed, while the other varies from day to day? This is not impossible, if the shower of August 10-11th is really of a composite character,—part belonging to the stationary radiant and part to the shifting radiant,

whose position on these two days is almost the same. When the velocity of meteors can be determined with greater accuracy than at present, we may be able to show that the *Perseids* of August 10 and 11th are divisible into two sets, traveling with different velocities, one belonging to the stationary and the other to the shifting radiant; and by carrying these observations on velocities backwards and forwards, we may be able to analyze the earlier and later composite radiants and to segregate the stationary from the shifting portion of each observed shower. At present, however, we are a long way from any such analysis; and if the existence of the shifting radiant be conceded (though the evidence for it is not as conclusive as one could wish), we are still left in doubt as to the dates on which its activity begins and ceases, and even as to the rate of the shifting. It is very unscientific to base any theory of meteoric radiation on the supposed shifting of the *Perseid* radiant, while overlooking or disregarding the large number of cases in which no shifting whatever has been observed, though the shower sometimes lasts during the whole year. It is indeed the general acceptance of a theory according to which every radiant that continues to be active for more than one night ought to shift its position that renders it worth while to investigate the supposed shifting of the *Perseid* radiant at the length that I have done. Here, if nowhere else, observation is supposed to accord with theory. Is the accordance even in this one instance real? The answer is, at all events, not free from doubt.

For convenience of reference, I may note that the shifting shower is No. XL in Mr. DENNING's catalogue, while the various stationary radiants mixed up with it are Nos. VII, (perhaps VIII), XV, XXI, XXX, XXXII, XXXIX, XLIII (as regards two or three determinations), XLVII, L, LV, and to some extent LVI. The track of the shifting radiant seems to me to lie entirely within the space covered by some one or other of these stationaries, and all of them are active at the date when the shifting radiant is supposed to overlap them as well as before and after that date.
